

PITTING CORROSION OF INCOLOY 825 IN HOT ACIDIC BRINE UNDER
POTENTIOSTATIC CONTROL

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A stochastic pit initiation and growth model is currently under development for use in the design and performance assessment of corrosion-resistant candidate waste package container materials for the potential geological repository at Yucca Mountain [1-3]. This phenomenological model can simulate the time evolution of the distribution of pit depths on a metal surface exposed to an aggressive environment. Experimental data are required to fit the model parameters so that quantitative predictions can be made, to verify the accuracy of the model, to validate the basic model assumptions, and if necessary to re-formulate the model. This paper describes initial efforts to provide some of these data.

Efforts to date have focused on measurements of pit depth distribution evolution in Incoloy 825. These experiments involve exposing a flat specimen to an aggressive aqueous environment while applying a constant electrochemical potential to induce relatively rapid pitting under controlled conditions. Each specimen is removed from the aggressive environment following a prescribed exposure time and examined to measure the distribution of pit depths. The distribution evolution with increasing exposure time can then be compared with model predictions to test the assumptions and equations used in the model.

Specifically, potentiostatic polarization experiments were performed on 1 cm² samples of Incoloy 825 immersed at 90 °C in 5% NaCl aqueous solution containing sulfuric acid (pH \approx 2.6). Using optical microscopy, the depth of each pit was measured by calibrated focusing and the pit diameters were measured with a filar eyepiece. (Note that pits with depths less than about 25 μ m, of which there were many, were not measured). Examples of the measured pit depth and diameter distributions are given in Fig. 1. Consistent with model predictions [1,3], there is a peak in the distributions at an intermediate depth or diameter. However, the long tail in the distribution at large depths (or diameters) that is predicted by the model for long exposures is not observed in the short-exposure distributions given in Fig. 1. Longer time exposures are required to test this prediction of the model. Table 1 gives a summary of the measured pit depth data gathered to date. Although these data are insufficient to draw many firm conclusions, it appears that increasing the applied electrochemical potential, E_{app} , increases the number of pits per unit area. The effects of exposure time and electrochemical potential on pit depths are not yet clear.

Figure 1(c) shows an example of the distribution of pit aspect ratios, defined as the pit depth divided by the diameter. If the aspect ratio is less than one (broad, shallow pits), automated pit depth measurement techniques may be viable for future work, or the pit diameter (much easier to measure than pit depth) could be used as a conservative measure of damage. The data given in Fig. 1(c) reveal that all pits have an aspect ratio less than one for this experiment, though testing under somewhat different conditions

resulted in aspect ratios of up to 2. Again, more data are required to make a firm conclusion regarding pit aspect ratios in Alloy 825.

In summary, the preliminary data are qualitatively consistent with stochastic model predictions of a peak in the pit depth distribution at intermediate depths, and show that Incoloy 825 is susceptible to pitting under aggressive conditions. The model prediction of a long tail in the distribution at large depths following long exposures has not yet been confirmed experimentally for this alloy.

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References

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Table 1. Pit depth distribution data for 1 cm² samples of Incoloy 825 immersed in acidified brine (5% NaCl) at 90 °C.

E_{app} (mV SHE)	Exposure Time (min.)	pH	Number of Pits	Maximum Depth (mm)	Median Depth (mm)
372	480	2.67	1	0.361	0.361
382	120	2.66	6	0.653	0.449
382	232	2.64	34	0.899	0.621
392	218	2.51	21	0.822	0.681
402	240	2.57	68	0.505	0.363

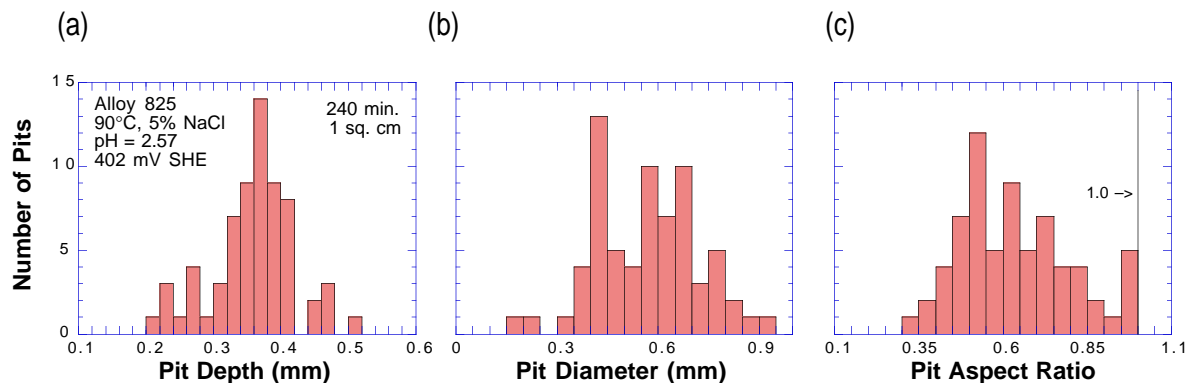


Figure 1. Experimental distributions of (a) pit depth, (b) diameter, and (c) aspect ratio for Incoloy 825 potentiostatically polarized (402 mV SHE) in an acidified, 5% NaCl solution at 90 °C for 240 minutes.